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WASHINGTON STATE DEPARTMENT OF ECOLOGY

WHIDBEY ISLAND NAVAL AIR STATION CLASS II INSPECTION

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INTRODUCTION

Ecology conducted a Class II inspection at the Whidbey Island Naval Air Station (NAS) on December 12-14, 1988. Norm Glenn, Don Reif and Keith Seiders conducted the inspection. Aaron Atwood, a City of Oak Harbor wastewater treatment plant (WTP) operator, provided assistance.

A portion of the NAS, the Seaplane Base, is located east of the City proper and is partly within the corporate boundaries of the City of Oak Harbor (see Figure 1). The Seaplane Base has not been considered in the City's previous sewage planning area because the Navy has traditionally treated its own wastes. But the City has experienced significant growth in recent years and an increasing percentage of the flow to the City's WTP has been contributed from housing for Navy personnel.

The Navy and City signed an agreement in 1988 turning over operation of the Seaplane Base lagoon system to the City. The agreement was seen as a reasonable solution for the overloaded municipal plant since some of the wastewater can be diverted to the lagoon system. The City is already making plans to expand it.

Effluent quality at the Seaplane Base lagoon system is regulated by National Pollutant Discharge Elimination System (NPDES) permit WA-000346-8 issued May 21, 1987, by Environmental Protection Agency (EPA), Region X.

Objectives of this survey included:

1. Characterize the wastewater chemically to identify pollutants.
2. Verify that the permittee's self-monitoring is adequate and includes required Quality Assurance/Quality Control (QA/QC) procedures.
3. Analyze performance of the WTP by determining loading and efficiency.
4. Quantify "benefits" to the environment by characterizing WTP performance preceding and, at a later date, following upgrade.
5. Characterize the sludge chemically by identifying toxic components.

SITE DESCRIPTION

The Seaplane Base lagoon system, which was expanded to its present configuration in 1971, is located immediately north of Crescent Harbor. The site occupies the southern portion of a large, relatively flat area which is generally poorly drained, swampy and classified by the State of Washington as a wildlife management area (URS, 1987).

The system consists of two lagoons designed to operate in series. The water surface in the large first cell covers an area of approximately 23 acres, while the surface area of the smaller second cell is approximately three acres. The maximum design depth of both cells is four feet. When designed, the lagoons were intended to operate as stabilization ponds with a total capacity of 550,000 gpd.

The lagoon system has since been upgraded by adding floating surface aerators near the end of the two influent pipes in the first cell. A physical-chemical treatment system has also been added to remove suspended solids from the lagoon effluent during periods of high algae growth. The physical-chemical system consists of two flash mix basins, two flocculation basins, and two rectangular clarifiers. Ferric sulfate and polymer are used as coagulants. Solids removed in the clarifiers are returned to the first stage lagoon. The operators of the plant report that the physical-chemical system is seldom needed to meet the effluent suspended solids limitation of 75 mg/L (URS, 1987). This limitation is contained in the federally issued permit.

During normal operation, lagoon effluent is chlorinated upstream of a small, baffled chlorine contact tank which discharges into a small holding pond. When the physical-chemical system is used, chlorine can be added ahead of either the flash mix tanks or the flocculator, thus using the clarifiers as contact tanks. Effluent from the clarifiers also discharge to the holding pond. From the holding pond, the effluent flows by gravity via an outfall into Crescent Harbor. A process flow schematic is shown on Figure 2.

The physical-chemical system is designed for an average daily flow of 885,000 gpd--which is presumed to be the design capacity of the Seaplane Base treatment facility.

METHODS

Grab and composite samples of influent and effluent wastewater were collected on December 13 and 14, 1988. Sludge samples were collected and composited from the large lagoon. The sampling schedule and list of parameters analyzed is shown in Table 1. Sampling locations are shown in Figure 3. Split sample analyses were performed for BOD_5 and total suspended solids (TSS).

Ecology collected two influent and one effluent composite samples. The first influent was taken at the Parshall flume in the 15-inch line serving predominantly the Seaplane Base activities and was coded Influent-C-ECO. The second influent was taken at the flume in the ten-inch line serving the housing development and was coded Influent-R-ECO. The effluent sample was taken from the small holding pond near the upstream end of the outfall line. It was coded Effluent-ECO. ISCO automatic samples collected about 330 mL of sample every 30 minutes for 24 hours. The samples were continually iced.

All three Ecology composite samplers were fitted with teflon tubing and glass sampling bottles. The transfer blank was run through the Ecology effluent compositor. The first one-third gallon was swirled around in the five gallon ISCO glass bottle and then discarded. The next one and two-thirds gallon was poured from the bottle into sample containers.

Two VOA transfer blank containers were used. One had been sent from the Manchester Lab filled; one was sent empty. The first was poured into the second and additional water added from the five gallon bottle to create a meniscus. This was tagged VOA[1]. The first was then filled from the bottle and tagged VOA[2].

Oak Harbor also collected two influent and an effluent sample from the same locations. Their effluent compositor was started one hour earlier than Ecology's. Their samples were to be coded Influent-C-NAS, Influent-R-NAS, and Effluent-NAS respectively; however, the first compositor failed during the night and no Influent-C-NAS samples were gathered. Oak Harbor samples were not iced, but the ambient temperature was at or below 4°C.

The grab samples for field and laboratory analyses were also collected at these sites.

Sludge samples were gathered from the 23 acre lagoon using two different techniques. While the sludge depth throughout the lagoon was of a fairly uniform depth (approximately six inches), it was much more firmly compacted in the westernmost two-thirds (Influent-C end) than the eastern one-third (Influent-R end).

The device used to sample the westernmost two-thirds was of our design modified from the Phleger corer. Cores were taken from seven locations surrounding the upwelling from the Influent-C discharge. The locations are shown on Figure 3. The bottom portion of each core appeared to be clay lagoon liner material, and was discarded.

The remainder was deposited into a large stainless steel bucket, homogenized with a stainless steel spoon, and placed into sample containers. The containers were tagged Sludge-1.

The device used to sample the eastern one-third was a Petite Ponar screen top sediment sampler. Grabs were taken from two locations around the upwelling from Influent-R (see Figure 3). The grabs were each deposited into a large stainless steel bucket, homogenized, placed into sample containers and tagged Sludge-2. The sampling conformed to procedures outlined in "Puget Sound Protocols" (Tetra Tech, 1986a).

All sampling equipment was cleaned before use by washing with non-phosphate detergent and rinsing successively with tap water, ten percent nitric acid, then three times with de-ionized water, pesticide grade methylene chloride, and with pesticide grade acetone. Collection equipment was air-dried and then wrapped in aluminum foil until used. Analog and digital pH meters were calibrated using pH 7 and 10 buffers.

Analytical methods and laboratories used are shown in Appendix A.

RESULTS AND DISCUSSION

Flow

The discharger's flow measuring capability was inadequate. There was no weir or recording device prior to discharge to Crescent Harbor. There were Parshall flumes at each of the influent stations, but they were ineffective. Influent-C had highly variable flows, probably due to pump station(s) further upstream. The Influent-R automatic recording device was not working on either day. It also appeared to be subject to highly variable flows. This made several instantaneous readings of little value and actually resulted in inundation of the flume.

Ecology set up a Sigma 8100 bubbler flow meter at the outflow from the chlorine contact chamber. It recorded a very consistent flow during the 24-hour period totaling 0.4 mgd. However, with no weir present the recording is somewhat suspect.

Characteristics of Wastewater

General Chemistry Results

Ecology's analytical results are summarized in Table 2.

Ecology's influent composite from the housing development side (Influent-R) had a high TSS concentration relative to the three grabs collected at that site (TSS in the composite was more than twice the average of the three grabs). Ecology's influent composite on the seaplane base side (Influent-C) was slightly higher in TSS than any of the grab samples. The effluent composite and grab TSS results were in good agreement.

The most plausible explanation for the inconsistency between influent grab and composite samples is that the grab samples were not representative of the 24-hour flow due to dramatic changes in flow volumes. A wet well/pump arrangement at the end of each collection system delivered slug flows which could have affected the representativeness of samples.

BOD_5 analysis was conducted on composite samples only. The mean and range of grab sample COD compared to composite sample COD results indicate that the BOD_5 composite results may be representative of the 24-hour flow.

Priority Pollutant Results

Several priority pollutant organics were detected at low levels in both influent streams (Table 3). Acetone and methylene chloride, (used in cleaning the sampling equipment), bis(2-ethylhexyl) phthalate, and the pesticide Lindane were found at low levels in the effluent. No priority pollutant organics were found in the effluent at levels exceeding marine water quality criteria (EPA, 1986).

Several metals were detected in influent and effluent samples. Correcting for the reagent blank values reported by the laboratory reduced the metals detected to those listed in Table 4. The field transfer blank was found to be contaminated with chromium, nickel and copper. The level of transfer blank contamination was sufficient to cast doubt on the accuracy of the reported concentrations of these metals in the influent and effluent samples. Copper, detected in the effluent at 15 ug/L and in the transfer blank at 4 ug/L, may exceed the marine acute water quality criteria of 2.9 ug/L (EPA, 1986). No other metals were detected at levels exceeding marine water quality criteria.

Cyanide was found at 6 ug/L in the effluent but was also detected in the transfer blank at 2 ug/L (Table 2). Effluent cyanide may exceed the acute and chronic marine water quality criteria of 1 ug/L (EPA, 1986).

Biomonitoring was not conducted as part of this inspection.

Assessment of Self-Monitoring

Laboratory analysis: The WTP laboratory analyses for BOD_5 and TSS agreed well with Ecology's for all samples tested (Table 5).

Composite sampler performance: There were BOD_5 and TSS differences in the samples collected by the WTP and Ecology compositors at Influent-R. The reason for the observed differences could be related to the wet well/pump arrangement at the collection stations. Ecology experienced difficulty in obtaining agreement between composite and grab samples at this location as discussed above. As stated previously, the WTP sampler at Influent-C failed during the night and a sample was not collected.

Calculations: From the bench sheets supplied by the laboratory in Oak Harbor, it appears that an error was made in the way the combined TSS and BOD_5 influent concentrations, and therefore, influent loadings were determined for the WTP. BOD_5 and TSS concentrations obtained for each influent stream were simply added together to obtain total influent TSS and BOD_5 concentrations for the WTP. The correct calculation requires multiplying each concentration by the fraction of flow that its waste stream contributes to the total influent flow before the concentrations are added. In order to do this, accurate flows for each influent stream are required.

It is also apparent from the bench sheets that the total influent flow was considered to be the same as the effluent flow. However, considerable seepage from the lagoons is known to occur (URS, 1987). Figure 4 shows the relationship between influent and effluent flow from October 83 through August 85. When the total influent flow is used to calculate effluent loading, the effluent load is overstated.

Assuming that the erroneously determined total influent BOD_5 concentrations and effluent loads were used, the BOD_5 removal efficiencies reported on the Discharge Monitoring Reports are incorrect.

WTP Loading and Efficiency

BOD_5 and TSS loads to the receiving water are 57 and 100 lb/day respectively based on Ecology's effluent flow measurement of .4 MGD. This flow rate has previously been discussed as being somewhat suspect, however, it is consistent with the historical effluent flows for mid-December as shown by Figure 4.

WTP efficiency and performance cannot be evaluated without accurate flows for the two influent streams. This emphasizes the need for accurate flow measuring devices on influent and effluent streams.

Comparing the inspection results to the NPDES permit limits was not an objective of the survey. Sufficit to say, the BOD_5 result of 17 mg/L and the TSS result of 30 mg/L were well within the limits of 30 and 75, respectively.

Characterization of sludge

Several organic and inorganic priority pollutants were found in the sludge, especially that collected from the influent-C (Seaplane Base) end of the lagoon. The pollutants detected along with pollutant limits for two disposal methods for sludge are presented in Table 6. No pollutants were found above limits for surface disposal or monofill disposal over Class II ground water (EPA, 1989).

CONCLUSIONS AND RECOMMENDATIONS

The upgraded WTP should have accurate and reliable flow measuring devices on influent and effluent streams. These devices must be regularly maintained and calibrated.

Analysis of the effluent indicated the possible presence of copper and cyanide at levels exceeding marine water quality criteria. No other chemicals were detected at levels above criteria.

Agreement between laboratories on individual split samples was very good.

The influent composite sampler locations should be evaluated to ensure that composite samples are representative of the waste streams.

Combined influent TSS and BOD_5 concentrations were calculated incorrectly on the WTP laboratory bench sheet. The use of an incorrect combined influent BOD_5 concentration in loading calculations would result in the reporting of erroneous BOD_5 reductions on Discharge Monitoring Reports. Bench sheets should be reviewed to determine if combined TSS and BOD_5 calculations are correct.

Analysis of sludge samples indicated the presence of several priority pollutants. None of these chemicals was present at levels exceeding the EPA's proposed limits for disposal in sludge-only landfills (monofills) or surface disposal sites.

REFERENCES

APHA-AWWA-WPCF, 1985, Standard Methods for the Examination of Water and Wastewater, 16th ed.

Ecology, 1988a, Department of Ecology Laboratory Users Manual.

EPA, 1983, Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, revised March 1983.

EPA, 1984, 40 CFR Part 136, October 26, 1984.

EPA, 1986, Quality Criteria for Water, EPA 440/5-86-001.

EPA, 1986a, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd ed., November 1986.

EPA, 1989, 40 CFR Parts 257 and 503, Standards for the Disposal of Sewage Sludge; Proposed Rule, February 6, 1989.

Tetra Tech, 1986, Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound, Prepared for Puget Sound Estuary Program.

URS, 1987, Upgrade of Secondary Treatment Facilities NAS/Seaplane Base, Prepared for the City of Oak Harbor, February 1987.

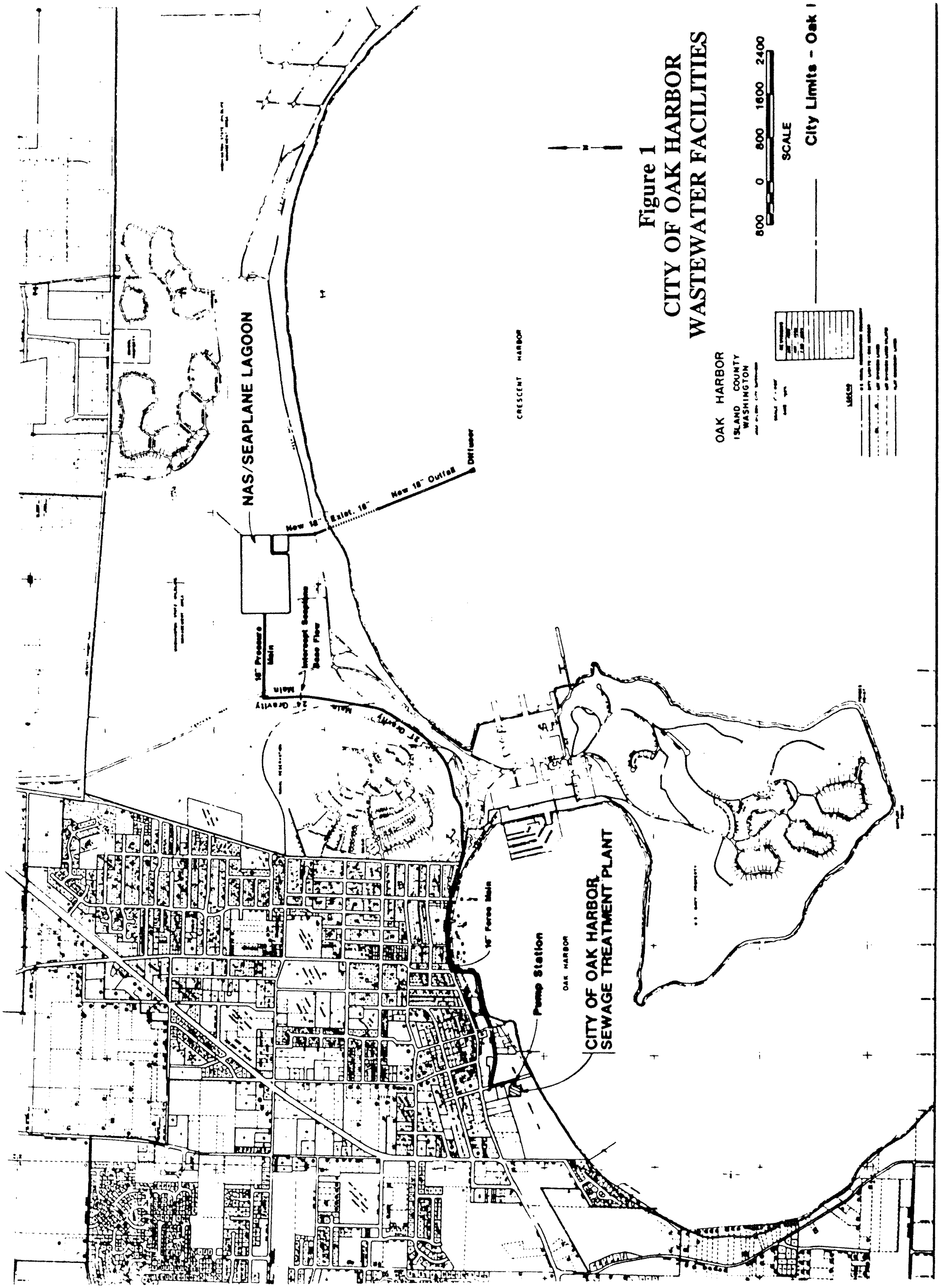

Figure 1
CITY OF OAK HARBOR
WASTEWATER FACILITIES

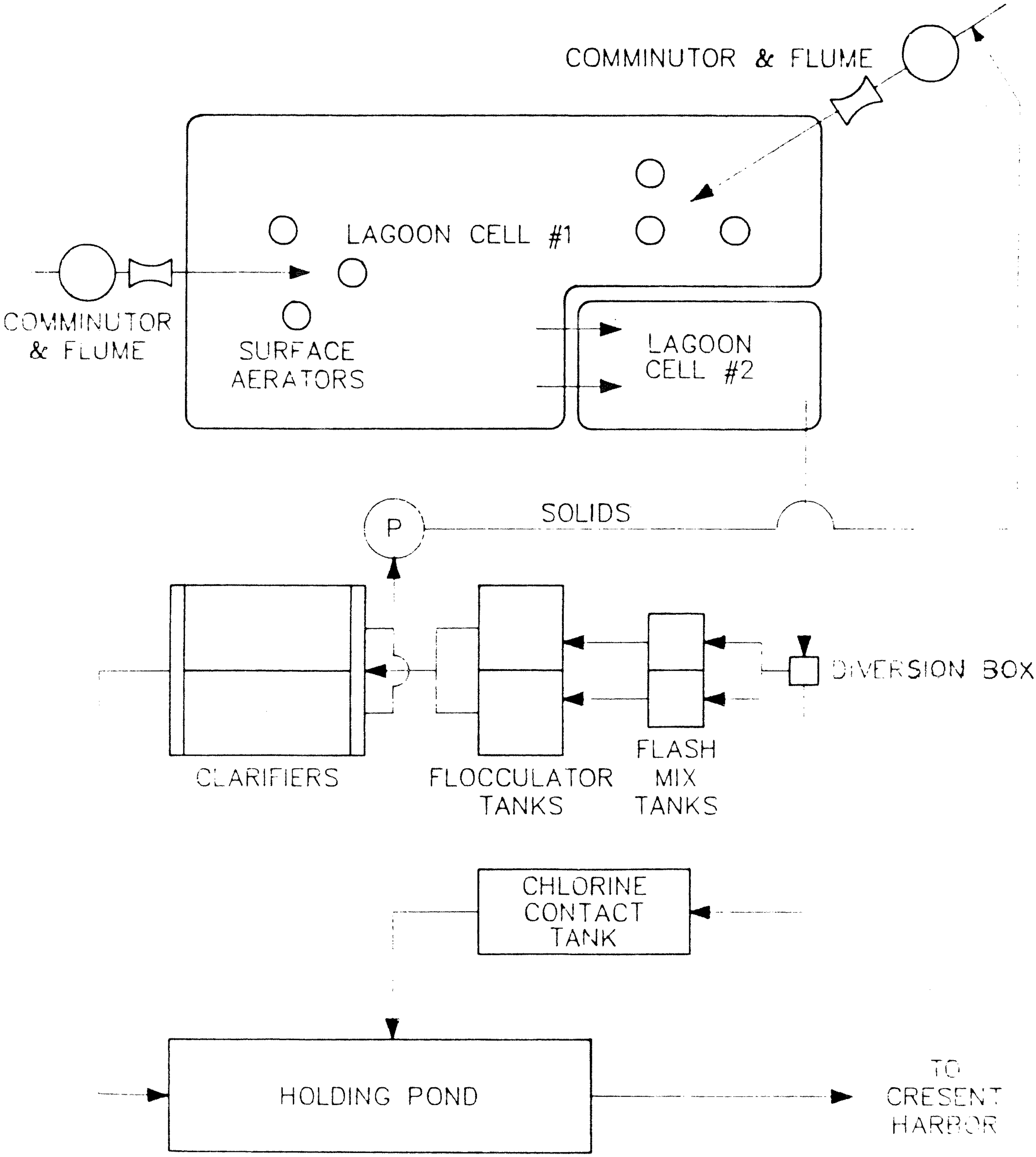

Figure 2
FLOW SCHEMATIC

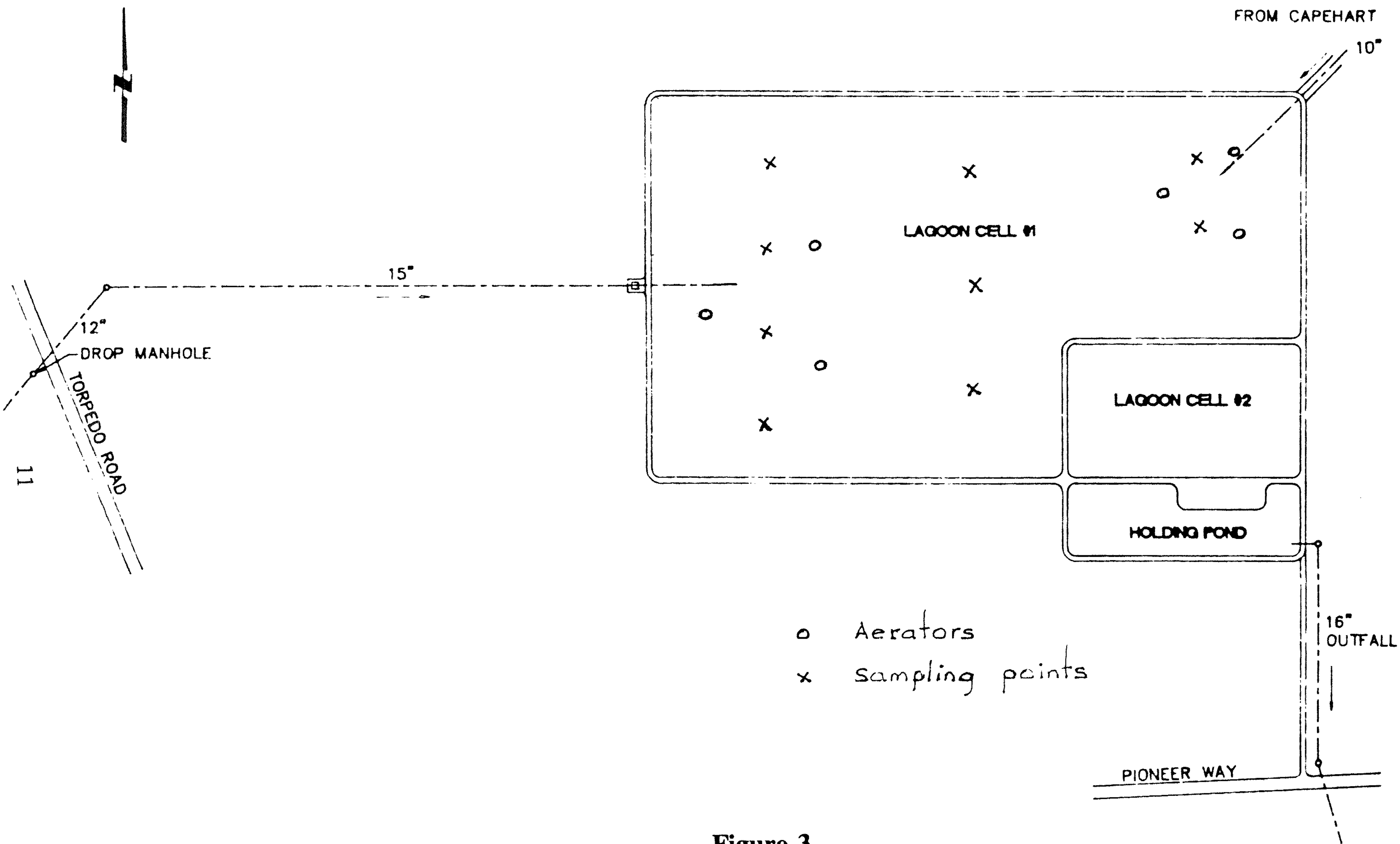

Figure 3
EXISTING SEAPLANE BASE LAGOONS

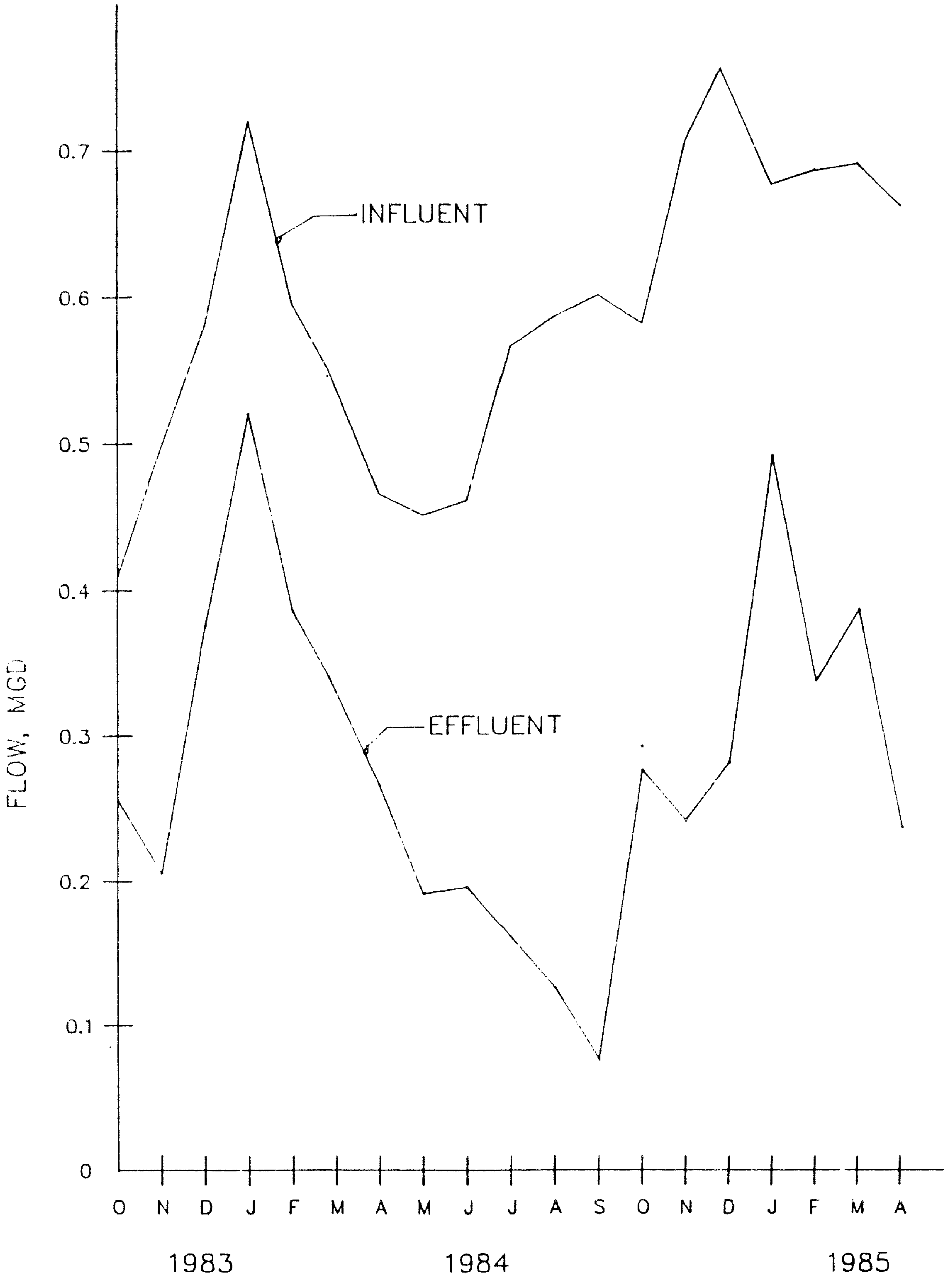

Figure 4
INFLUENT FLOW vs. EFFLUENT FLOW
SEAPLANE BASE LAGOON

Table 1 - Sampling times and parameters analyzed - Whidbey Island NAS, 12/88.

Station:	Influent-R					Influent-C				Effluent					Sludge-1	Sludge-2	Blank
Type:	Grab	Grab	Grab	Composite	Composite	Grab	Grab	Grab	Composite	Grab	Grab	Grab	Composite	Composite	Composite	Composite	Transfer
Date:	13	13	14	13-14	13-14	13	13	14	13-14	13	13	14	13-14	13-14	13	13	13
Time:	1210	1535	0910	1015-1020	1015-1015*	1150	1515	0830	0950-0950	1130	1625	0930	1055-1050	0955-0955*	pm	pm	1030
Parameter / Sample ID #:	518180	518182	518184	518190	518189	518181	518183	518185	518191	518186	518187	518188	518193	518197	518195	518194	518198
GENERAL CHEMISTRY																	
Turbidity (NTU)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Conductivity (umhos/cm)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Alkalinity (mg/L as $CaCO_3$)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Hardness (mg/L as $CaCO_3$)				X					X				X				
Cyanide (mg/L) **				X					X				X		X	X	X
SOLIDS (mg/L)																	
TS				X	X				X				X	X			
TNVS				X	X				X				X	X			
TSS	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
TNVSS				X	X				X				X	X			
BOD_5 (mg/L)				X	X				X				X(X)+	X			
COD (mg/L)	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
NUTRIENTS (mg/L)																	
NH_3-N	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
NO_3+NO_2-N	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
T-Phosphate	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Fecal Coliform (#/100mL)											X	X					
% Solids															X	X	
Phenols (mg/L)				X					X				X				
TOC (mg/kg - dry)															X	X	
ORGANICS AND METALS																	
BNA's				X					X				X		X	X	X
Pest/PCB				X					X				X		X	X	X
VOA		X	X				X	X			X	X			X	X	X
Metals				X					X				X		X	X	X
FIELD OBSERVATIONS																	
Temp (°C)	X	X	X	X		X	X	X	X	X	X	X	X				
pH (S.U.)	X	X	X	X		X	X	X	X	X	X	X	X				
Conductivity (umhos/cm)	X	X	X	X		X	X	X	X	X	X	X	X				
Chlorine (mg/L)											X						

* - Samples collected by NAS equipment
\+ - Inhibited BOD5 test
** - Units for sludge are mg/kg - dry

Table 2 - Ecology results for general chemistry parameters - Whidbey Island NAS, 12/88.

Station:	Influent-R					Influent-C				Effluent					Sludge-1	Sludge-2	Blank
Type:	Grab	Grab	Grab	Composite	Composite	Grab	Grab	Grab	Composite	Grab	Grab	Grab	Composite	Composite	Composite	Composite	Transfer
Date:	13	13	14	13-14	13-14	13	13	14	13-14	13	13	14	13-14	13-14	13	13	13
Time:	1210	1535	0910	1015-1020	1015-1015*	1150	1515	0830	0950-0950	1130	1625	0930	1055-1050	0955-0955*	pm	pm	1030
Parameter Sample ID #:	518180	518182	518184	518190	518189	518181	518183	518185	518191	518186	518187	518188	518193	518197	518195	518194	518198
GENERAL CHEMISTRY																	
Turbidity (NTU)	17	15	21	17	27	13	27	21	14	12	12	12	12	11			
Conductivity (umhos/cm)	390	440	470	510	500	310	680	640	770	6810	5130	4870	6770	8020			
Alkalinity (mg/L as $CaCO_3$)	120	145	150	160	160	90	190	200	150	120	120	120	120	110			
Hardness (mg/L as $CaCO_3$)				63					110				720				
Cyanide (mg/L) **				.006					.004				.006		.06 **	.05 U**	.002
SOLIDS (mg/L)																	
TS				650	460				540				4100	8200			
TNVS				340	230				350				3500	7000			
TSS	61	53	88	200	120	56	76	62	100	29	24	22	30	24			
TNVSS				36	17				13				8	12			
BOD_5 (mg/L)				240	160				120				17(10)+	13			
COD (mg/L)	530	240	380	500	310	200	340	320	290	120	120	130	160	190			
NUTRIENTS (mg/L)																	
NH_3-N	4.5	8.1	13	14	12	4.3	14	14	13	11	11	11	11	9.8			
NO_3+NO_2-N	0.40	0.49	0.38	0.40	0.36	0.32	0.16	0.28	0.33	1.1	1.2	1.2	1.2	1.1			
T-Phosphate	5.0	5.1	6.5	5.6	6.5	2.6	7.7	4.7	6.0	5.4	6.3	4.5	6	5.4			
Fecal Coliform (#/100mL)											37	37					
% Solids															33.0	8.3	
Phenols (mg/L)				0.016					0.014				0.003				
TOC (mg/kg - dry)															12	21	
FIELD OBSERVATIONS																	
Temp (°C)	15.0	14.1	14.2	3.4		13.8	13.9	13.0	2.4	6.8	7.1	4.8	2.9				
pH (S.U.)	7.67	7.86	8.20	7.90		7.59	7.57	8.15	7.61	7.76	7.61	7.70	7.76				
Conductivity (umhos/cm)	300	370	350	520		340	540	670	620	5920	4460	4560	6200				
Chlorine (mg/L)													0.0				

* - Samples collected by NAS equipment
\+ - Inhibited BOD5 test
U - Undetected at given detection level
** - Units for sludge are mg/kg - dry

Table 3. Compounds detected in influent, effluent and lagoon sludge - Whidbey Island NAS, 12/88.

Station:	Influent-R	Influent-R	Influent-C	Influent-C	Effluent	Effluent	Field Blank	Sludge-1	Sludge-2
Type:	grab	grab	grab	grab	grab	grab	transfer	grab	grab
Date:	12/13	12/13	12/13	12/14	12/13	12/14	12/13	12/13	12/13
Time:	pm	am	pm	am	pm	am	am	pm	pm
Sample ID #:	518182	518184	518183	518185	518187	518188	518198	518195	518194
Volatile Organics:	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/Kg)	(ug/Kg)
Methylene Chloride	0.8 JB	0.9 JB	0.6 JB	10 B	3.7 B	1.0 JB	1500 B	38 U	21 U
Acetone	1000	22	240	23	86	0.6 U	2300	68 U	460
Chloroform	8.0	7.3	4.2	7.5	0.9 U	0.9 U	0.9 U	11 U	6.0 U
Toluene	0.6	0.6 U	0.6 U	0.9	0.6 U	0.6 U	0.6 U	120	320
Ethylbenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	7.9	3.7 J
Total Xylenes	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	18 J	9.9 U

Station:	Influent-R	Influent-C	Effluent	Field Blank	Sludge-1	Sludge-2
Type:	composite	composite	composite	transfer	composite	composite
Date:	12/13-14	12/13-14	12/13-14	12/13	12/13	12/13
Sample ID #:	518190	518191	518193	518198	518195	518194
Low molecular weight PAHs:	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/Kg)	(ug/Kg)
Naphthalene	1 U	1 J	1 U	1 U	140 J	94 U
2-Methylnaphthalene	1 U	1 J	1 U	1 U	130 J	94 U
High molecular weight PAHs:						
Fluoranthene	1 U	1 U	1 U	1 U	660	94 U
Pyrene	1 U	1 U	1 U	1 U	540	94 U
Benzo(a)Anthracene	1 U	1 U	1 U	1 U	270 J	94 U
Chrysene	1 U	1 U	1 U	1 U	440	94 U
Benzo(b)Fluoranthene	1 U	1 U	1 U	1 U		94 U
Benzo(k)Fluoranthene	1 U	1 U	1 U	1 U	830 M	94 U
Benzo(a)Pyrene	1 U	1 U	1 U	1 U	280 J	94 U
Phenols:						
Phenol	4	2 M	1 U	1 U	610 M	94 U
4-Methylphenol	1 U	9	1 U	1 U	300 U	94 U
Phthalate esthers:						
Diethyl Phthalate	8	8	1 U	1 U	300 U	94 U
Di-n-Butyl Phthalate	2	26	1 U	1 U	970	94 U
Butylbenzylpthalate	2	5	1 U	1 U	570	94 U
Bis(2-Ethylhexyl)phthalate	17	19	3	1 U	23000	670
Di-n-Octyl Phthalate	2	3	1 U	1 U	990	94 U
Pesticide/PCB compounds:						
gamma-BHC (Lindane)	0.09	0.36	0.01 J	0.03 U	10 U	3.0 U
4,4'-DDE	0.06 U	0.06 U	0.06 U	0.06 U	81	3.0 J
4,4'-DDD	0.06 U	0.06 U	0.06 U	0.06 U	39	18
4,4'-DDT	0.06 U	0.06 U	0.06 U	0.06 U	7.0 J	6.2
Aroclor-1254	0.6 U	0.6 U	0.6 U	0.6 U	1400	32 J
Neutral halogenated compounds:						
1,4-Dichlorobenzene	6	1	1 U	1 U	300 U	94 U
Miscellaneous:						
Benzyl Alcohol	7	8	5 U	5 U	1500 U	470 U
4-Chloroaniline	3 U	1 M	3 U	3 U	1500	280 U

B - This flag is used when the analyte is found in the blank as well as the sample. Indicates possible/probable blank contamination.
J - Indicates an estimated value when result is less than specified detection limit.
M - Indicates an estimated value of analyte found and confirmed by analyst but with low spectral match parameters.
U - Indicates compound was analyzed for but not detected at the given detection limit.

Table 4. Ecology results for metals (corrected for reagent) - Whidbey Island NAS, 12/88.

Station: Type:	Influent-R composite	Influent-C composite	Effluent composite	Field Blank transfer	Water quality criteria* (marine) Acute	Chronic
Metals	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Chromium	129	45	71	121	10,300 **	
Copper	178	33	15	4	2.9	
Lead	7.2				140	5.6
Mercury	0.1				2.1	0.025
Nickel	100	40	50	100	140	7.1
Zinc	95	77	15		170	58

* - EPA, 1986 (Quality Criteria for Water)
** - L.O.E.L. (Lowest observed effects level)

Table 5. Assessment of Self-Monitoring - Whidbey Island Nas, 12/88.

Station	Sampler	Laboratory	BOD_5	TSS
Influent-R	Ecology	Ecology	240	200
		WTP	*	*
	WTP	Ecology	160	120
		WTP	147	106
Influent-C	Ecology	Ecology	120	100
		WTP	124	99
	WTP	Ecology	**	**
		WTP	**	**
Effluent-combined	Ecology	Ecology	17	30
		WTP	20	37
	WTP	Ecology	13	24
		WTP	19	35

* - not analyzed by WTP
** - sampling equipment failed

Table 6. Ecology Sludge analysis - Whidbey Island NAS, 12/88.

Station:	Sludge-1 (Seaplane base side)	Sludge-2 (Residential side)	Surface disposal limits* +	Monofills over Class II ground-water limts* + +
Volatile Organics: (ug/Kg-dry)				
Acetone	68 U	460		
Toluene	120	320		
Ethylbenzene	7.9	3.7 J		
Total Xylenes	18 J	9.9 J		
Low molecular weight PAHs: (ug/Kg-dry)				
Naphthalene	140 J			
2-Methylnaphthalene	130 J			
High molecular weight PAHs: (ug/Kg-dry)				
Fluoranthene	660			
Pyrene	540			
Benzo(a)Anthracene	270 J			
Chrysene	440			
(Benzo(b)Fluoranthene + Benzo(k)Fluoranthene)	830 M			
Benzo(a)Pyrene	280 J		99,000	250,000
Phenols: (ug/Kg-dry)				
Phenol	610 M			
Phthalate esters: (ug/Kg-dry)				
Di-n-Butyl Phthalate	970			
Butybenzylphthalate	570			
Bis(2-Ethylhexyl)phthalate	23,000	670	782,000	1,600,000
Di-n-Octyl Phthalate	990			
Pesticides/PCBs: (ug/Kg-dry)				
4,4'-DDE	81	3.0 J	950	51,000
4,4'-DDD	39	18		
4,4'-DDT	7.0 J	6.2		
Arochlor-1254	1,400	32 J	49,000	49,000
Miscellaneous: (ug/Kg-dry)				
4-Chloroaniline	1,500			
Metals: (mg/Kg-dry)				
Antimony	5.19 J	0.502 J		
Arsenic	11.3 J	7.72 J	36	24
Beryllium		0.42		
Cadmium	6.82	5.04	385	9.6
Chromium	43.0 J	38.0 J		
Copper	643	31.8	3,300	
Lead	106	11.7	1,622	530
Mercury	1.56	0.07	17	26
Nickel	53.1	38.5	988	
Selenium	4.08	0.740		
Silver	4.79			
Zinc	591 B	53.0 B		

* - EPA, 1989 (Standards for the Disposal of Sewage Sludge; Proposed Rule).
** - Monofill site is an area of land receiving only sewage sludge, typically a trenching operation with a daily soil cover.
\+ - Surface disposal site is an area of land on which only sewage sludge is placed for 1 year or longer. No vegetative cover is used.
B - This flag is used when the analyte is found in the blank as well as the sample. Indicates possible/probable balnk contamination.
J - Indicates an estimated value when result is less than specified detection limit.
M - Indicates an estimated value of analyte found and confirmed by analyst but with low spectral match parameters.
U - Indicates compound was analyzed for but not detected at the given detection limit.

Appendix A. Analytical Methods and Laboratories used - Whidbey Island NAS, 12/88.

Laboratory Analyses	Method used for Ecology analysis (Ecology, 1988)	Laboratory performing analysis
Turbidity	APHA, 1985: 214A	Ecology
Conductivity	APHA, 1985: 205	Ecology
Alkalinity	APHA, 1985: 403	Ecology
Hardness	APHA, 1985: 314B	Ecology
Cyanide	EPA, 1983: 335.2-1	Ecology
Total solids	APHA, 1985: 209A	Ecology
Total nonvolatile solids	APHA, 1985: 209D	Ecology
Total suspended solids	APHA, 1985: 209C	Ecology
Total nonvolatile suspended solids	APHA, 1985: 209D	Ecology
Total volatile suspended solids	APHA, 1985: 209D	Ecology
BOD_5	APHA, 1985: 507	Ecology
COD	APHA, 1985: 508C	Ecology
NH_3-N	EPA, 1983: 350.1	Ecology
NO_3+NO_2-N	EPA, 1983: 353.2	Ecology
T-Phosphate	EPA, 1983: 365.1	Ecology
Fecal coliform	APHA, 1985: 909C	Ecology
% Solids	APHA, 1985: 209F	Laucks
Phenols	EPA, 1983: 420.1	Ecology
TOC (sediments)	Tetra Tech, 1986	Laucks
BNA's (water)	EPA, 1984: 625	Analytical Resources Inc.
BNA's (dolids	EPA, 1986a: 8270	Analytical Resources Inc.
PCB/Pesticides (water)	EPA, 1984: 608	Analytical Resources Inc.
PCB/Pesticides (solids)	EPA, 1986a: 8080	Analytical Resources Inc.
Volatile organics (water)	EPA, 1984: 624	Analytical Resources Inc.
Volatile organics (solids)	EPA, 1986a: 8240	Analytical Resources Inc.
Metals-priority pollutant (water)	Tetra Tech, 1986	Analytical Resources Inc.
Metals-priority pollutant (solids)	Tetra Tech, 1986	Analytical Resources Inc.

Appendix B. Results of priority pollutant VOA scan - Whidbey Island NAS, 12/88.

Station:	Influent-R	Influent-R	Influent-C	Influent-C	Effluent	Effluent	Field Blank	Sludge-1	Sludge-2
Type:	grab	grab	grab	grab	grab	grab	transfer	grab	grab
Date:	12/13	12/13	12/13	12/14	12/13	12/14	12/13	12/13	12/13
Time:	pm	am	pm	am	pm	am	am	pm	pm
Sample ID #:	518182	518184	518183	518185	518187	518188	518198	518195	518194
VOA Compounds	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/Kg)	(ug/Kg)
Chloromethane	2.9 U	2.9 U	2.9 U	2.9 U	2.9 U	2.9 U	2.9 U	37 U	21 U
Bromomethane	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	30 U	17 U
Vinyl Chloride	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	20 U	11 U
Chloroethane	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	32 U	18 U
Methylene Chloride	0.8 JB	0.9 JB	0.6 JB	10 B	3.7 B	1.0 JB	1500 B	38 U	21 U
Acetone	1000	22	240	23	86	0.6 U	2300	68 U	460
Carbon Disulfide	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	12 U	6.6 U
1,1-Dichloroethene	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	6.9 U	3.8 U
1,1-Dichloroethane	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	5.9 U	3.3 U
Trans-1,2-Dichloroethene	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	-	-
Cis-1,2-Dichloroethene	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	1.2 U	-	-
Chloroform	8.0	7.3	4.2	7.5	0.9 U	0.9 U	0.9 U	11 U	6.0 U
1,2-Dichloroethane	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	4.9 U	2.7 U
2-Butanone	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	61 U	34 U
1,1,1-Trichloroethane	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	5.9 U	3.3 U
Carbon Tetrachloride	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	8.8 U	4.9 U
Vinyl Acetate	1.7 U	1.7 U	1.7 U	1.7 U	1.7 U	1.7 U	1.7 U	30 U	17 U
Bromodichloromethane	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	2.9 U	1.6 U
1,2-Dichloropropane	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	6.9 U	3.8 U
Trans-1,3-Dichloropropene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	19 U	10 U
Trichloroethene	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	0.8 U	5.9 U	3.3 U
Dibromochloromethane	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	6.9 U	3.8 U
1,1,2-Trichloroethane	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	6.9 U	3.8 U
Benzene	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	9.8 U	5.5 U
Cis-1,3-Dichloropropene	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	18 U	9.9 U
2-Chloroethylvinylether	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	27 U	15 U
Bromoform	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	25 U	14 U
4-Methyl-2-Pentanone	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	34 U	19 U
2-Hexanone	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	31 U	18 U
Tetrachloroethene	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	4.9 U	2.7 U
1,1,2,2-Tetrachloroethane	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	27 U	15 U
Toluene	0.6	0.6 U	0.6 U	0.9	0.6 U	0.6 U	0.6 U	120	320
Chlorobenzene	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	8.8 U	4.9 U
Ethylbenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	7.9	3.7 J
Styrene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	11 U	6.0 U
Total Xylenes	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	1.5 U	18 J	9.9 U
1,2-Dichloroethene (total)	-	-	-	-	-	-	-	7.8 U	4.4 U

Appendix C. Results of priority pollutant BNA, Pesticide and PCB scan - Whidbey Island NAS, 12/88.

Station:	Influent-R	Influent-C	Effluent	Field Blank	Sludge-1	Sludge-2
Type:	composite	composite	composite	transfer	composite	composite
Date:	12/13-14	12/13-14	12/13-14	12/13	12/13	12/13
Sample ID #:	518190	518191	518193	518198	518195	518194
BNA Compounds	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/Kg)	(ug/Kg)
Phenol	4	2 M	1 U	1 U	610 M	94 U
Bis(2-Chloroethyl)Ether	1 U	1 U	1 U	1 U	300 U	94 U
2-Chlorophenol	1 U	1 U	1 U	1 U	300 U	94 U
1,3-Dichlorobenzene	1 U	1 U	1 U	1 U	300 U	94 U
1,4-Dichlorobenzene	6	1	1 U	1 U	300 U	94 U
Benzyl Alcohol	7	8	5 U	5 U	1500 U	470 U
1,2-Dichlorobenzene	1 U	1 U	1 U	1 U	300 U	94 U
2-Methylphenol	1 U	1 U	1 U	1 U	300 U	94 U
Bis(2-chloroisopropyl)ether	1 U	1 U	1 U	1 U	300 U	94 U
4-Methylphenol	1 U	9	1 U	1 U	300 U	94 U
N-Nitroso-Di-n-Propylamine	1 U	1 U	1 U	1 U	300 U	94 U
Hexachloroethane	2 U	2 U	2 U	2 U	600 U	190 U
Nitrobenzene	1 U	1 U	1 U	1 U	300 U	94 U
Isophorone	1 U	1 U	1 U	1 U	300 U	94 U
2-Nitrophenol	5 U	5 U	5 U	5 U	1500 U	470 U
2,4-Dimethylphenol	2 U	2 U	2 U	2 U	600 U	190 U
Benzoic Acid	10 U	10 U	10 U	10 U	3040 U	930 U
Bis(2-Chloroethoxy)Methane	1 U	1 U	1 U	1 U	300 U	94 U
2,4-Dichlorophenol	3 U	3 U	3 U	3 U	900 U	280 U
1,2,4-Trichlorobenzene	1 U	1 U	1 U	1 U	300 U	94 U
Naphthalene	1 U	1 J	1 U	1 U	140 J	94 U
4-Chloroaniline	3 U	1 M	3 U	3 U	1500	280 U
Hexachlorobutadiene	2 U	2 U	2 U	2 U	600 U	190 U
4-Chloro-3-Methylphenol	2 U	2 U	2 U	2 U	600 U	190 U
2-Methylnaphthalene	1 U	1 J	1 U	1 U	130 J	94 U
Hexachlorocyclopentadiene	5 U	5 U	5 U	5 U	1500 U	470 U
2,4,6-Trichlorophenol	5 U	5 U	5 U	5 U	1500 U	470 U
2,4,5-Trichlorophenol	5 U	5 U	5 U	5 U	1500 U	470 U
2-Chloronaphthalene	1 U	1 U	1 U	1 U	300 U	94 U
2-Nitroaniline	5 U	5 U	5 U	5 U	1500 U	470 U
Dimethyl Phthalate	1 U	1 U	1 U	1 U	300 U	94 U
Acenaphthylene	1 U	1 U	1 U	1 U	300 U	94 U
3-Nitroaniline	5 U	5 U	5 U	5 U	1500 U	470 U
Acenaphthene	1 U	1 U	1 U	1 U	300 U	94 U
2,4-Dinitrophenol	10 U	10 U	10 U	10 U	3000 U	930 U
4-Nitrophenol	5 U	5 U	5 U	5 U	1500 U	470 U
Dibenzofuran	1 U	1 U	1 U	1 U	300 U	94 U
2,4-Dinitrotoluene	5 U	5 U	5 U	5 U	1500 U	470 U
2,6-Dinitrotoluene	5 U	5 U	5 U	5 U	1500 U	470 U
Diethyl Phthalate	8	8	1 U	1 U	300 U	94 U
4-Chlorophenyl-Phenylether	1 U	1 U	1 U	1 U	300 U	94 U
Fluorene	1 U	1 U	1 U	1 U	300 U	94 U
4-Nitroaniline	5 U	5 U	5 U	5 U	1500 U	470 U
4,6-Dinitro-2-Methylphenol	10 U	10 U	10 U	10 U	3000 U	930 U
N-Nitrosodiphenylamine	1 U	1 U	1 U	1 U	300 U	94 U
4-Bromophenyl-Phenylether	1 U	1 U	1 U	1 U	300 U	94 U

Appendix C. (Continued)

Whidbey Island NAS, 12/88.

Station:	Influent-R	Influent-C	Effluent	Field Blank	Sludge-1	Sludge-2
Type:	composite	composite	composite	transfer	composite	composite
Date:	12/13-14	12/13-14	12/13-14	12/13	12/13	12/13
Sample ID #:	518190	518191	518193	518198	518195	518194
BNA Compounds	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/Kg)	(ug/Kg)
Hexachlorobenzene	1 U	1 U	1 U	1 U	300 U	94 U
Pentachlorophenol	5 U	5 U	5 U	5 U	1500 U	470 U
Phenanthrene	1 U	1 U	1 U	1 U	300 U	94 U
Anthracene	1 U	1 U	1 U	1 U	300 U	94 U
Di-n-Butyl Phthalate	2	26	1 U	1 U	970	94 U
Fluoranthene	1 U	1 U	1 U	1 U	660	94 U
Pyrene	1 U	1 U	1 U	1 U	540	94 U
Butylbenzylpthalate	2	5	1 U	1 U	570	94 U
3,3'-Dichlorobenzidine	5 U	5 U	5 U	5 U	1500 U	470 U
Benzo(a)Anthracene	1 U	1 U	1 U	1 U	270 J	94 U
Chrysene	1 U	1 U	1 U	1 U	440	94 U
Bis(2-Ethylhexyl)phthalate	17	19	3	1 U	23000	670
Di-n-Octyl Phthalate	2	3	1 U	1 U	990	94 U
Benzo(b)Fluoranthene	1 U	1 U	1 U	1 U		94 U
Benzo(k)Fluoranthene	1 U	1 U	1 U	1 U	830 M	94 U
Benzo(a)Pyrene	1 U	1 U	1 U	1 U	280 J	94 U
Indeno(1,2,3-cd)Pyrene	1 U	1 U	1 U	1 U	300 U	94 U
Dibenzo(a,h)Anthracene	1 U	1 U	1 U	1 U	300 U	94 U
Benzo(g,h,i)Perylene	1 U	1 U	1 U	1 U	300 U	94 U
Pesticide/PCB Compounds						
alpha-BHC	0.03 U	0.03 U	0.03 U	0.03 U	10 U	3.0 U
beta-BHC	0.03 U	0.03 U	0.03 U	0.03 U	10 U	3.0 U
delta-BHC	0.03 U	0.03 U	0.03 U	0.03 U	10 U	3.0 U
gamma-BHC (Lindane)	0.09	0.36	0.01 J	0.03 U	10 U	3.0 U
Heptachlor	0.03 U	0.03 U	0.03 U	0.03 U	10 U	3.0 U
Aldrin	0.03 U	0.03 U	0.03 U	0.03 U	10 U	3.0 U
Heptachlor Epoxide	0.03 U	0.03 U	0.03 U	0.03 U	10 U	3.0 U
Endosulfan I	0.09 U	0.09 U	0.09 U	0.09 U	30 U	9.0 U
Dieldrin	0.06 U	0.06 U	0.06 U	0.06 U	20 U	6.0 U
4,4'-DDE	0.06 U	0.06 U	0.06 U	0.06 U	81	3.0 J
Endrin	0.06 U	0.06 U	0.06 U	0.06 U	20 U	6.0 U
Endosulfan II	0.06 U	0.06 U	0.06 U	0.06 U	20 U	6.0 U
4,4'-DDD	0.06 U	0.06 U	0.06 U	0.06 U	39	18
Endosulfan Sulfate	0.06 U	0.06 U	0.06 U	0.06 U	20 U	6.0 U
4,4'-DDT	0.06 U	0.06 U	0.06 U	0.06 U	7.0 J	6.2
Methoxychlor	0.12 U	0.12 U	0.12 U	0.12 U	40 U	12 U
Endrin Ketone	0.06 U	0.06 U	0.06 U	0.06 U	20 U	6.0 U
alpha-Chlordane	0.06 U	0.06 U	0.06 U	0.06 U	20 U	6.0 U
gamma-Chlordane	0.06 U	0.06 U	0.06 U	0.06 U	20 U	6.0 U
Toxaphene	3.0 U	3.0 U	3.0 U	3.0 U	1000 U	300 U
Aroclor-1242/1016	0.6 U	0.6 U	0.6 U	0.6 U	200 U	60 U
Aroclor-1248	0.6 U	0.6 U	0.6 U	0.6 U	200 U	60 U
Aroclor-1254	0.6 U	0.6 U	0.6 U	0.6 U	1400	32 J
Aroclor-1260	0.6 U	0.6 U	0.6 U	0.6 U	200 U	60 U